

New leptonioid species from New South Wales and northeastern Queensland, Australia

DAVID L. LARGENT^{1*}, KERRI L. KLUTING²,
NOELLE M. ANDERSON³ & SARAH E. BERGEMANN³

¹Biological Sciences, Humboldt State University, 1 Harpst St, Arcata CA 95521, USA

²Department of Evolutionary Biology, Evolutionary Biology Centre, Uppsala University,
Uppsala, SE-752 36, Sweden

³Evolution & Ecology Group, Biology Department, Middle Tennessee State University,
PO Box 60, Murfreesboro TN 37132, USA

* CORRESPONDENCE TO: mrp@humboldt1.com

ABSTRACT — *Leptonia subpanniculus*, *L. newlingii*, *L. sabulosa*, and *L. substricta* are described as new species based on morphological and molecular characters. Phylogenetic relationships and morphological similarities are discussed for these and other closely related species.

KEY WORDS — Basidiomycota, Entolomaceae, taxonomy

Introduction

The morphologically defined genus *Leptonia* (Fr.) P. Kumm. is polyphyletic (Co-David et al. 2009). In the most recent taxonomic study of *Leptonia*, phylogenetic analyses strongly support *Entoloma euchroum* (Pers.) Donk [= *Leptonia euchroa* (Pers.) P. Kumm.], the type species of *Leptonia* and *Entoloma* subg. *Leptonia* (Fr.) Noordel. emend. Morozova et al. (2014), in a clade separated from the *Inocephalus*-*Cyanula* and *Nolanea*-*Claudopus* clades (Morozova et al. 2014). These authors have emended *Entoloma* subg. *Leptonia* to make it monophyletic and consistent with *Entoloma* sect. *Leptonia* (Noordeloos 2004) and *Leptonia* subg. *Leptonia* (Largent 1994). *Leptonia* subg. *Leptonia* sensu Largent is a diverse subgenus that includes species that are mycenoid, collybioid, or tricholomatoid; have a conico-convex or plano-convex pileus, a fibrillose-striate or flocculose-scaly (rarely almost smooth) stipe, lamellae with

sterile, fertile or heterogeneous edges, cheilocystidia present or absent, weakly to sharply angled (almost nodulose) basidiospores, a more or less a trichoderm pileipellis of inflated elements with intracellular (and often with additional encrusting) pigments, and clamp connections; and lack brilliant granules.

Here we describe and illustrate four new species from Australia: *L. sabulosa*, *L. subpanniculus*, *L. substricta*, and *L. newlingii*. Our molecular phylogeny supports these species and *L. ambigua* from Australia (Largent et al. 2013b) within *Leptonia* subg. *Leptonia* sensu Largent (1994). We also discuss the morphological and phylogenetic relationships among species in this clade.

Materials & methods

Macromorphological and micromorphological features

Techniques and equipment for collecting and describing basidiomata in the field and GPS coordinates follow Largent et al. (2011a,b). Kornerup & Wanscher (1978) color terms and factors determined from mathematical analyses used in the descriptions are in Largent et al. (2013a,b). Digitized microphotographs were made using a Lumenera Infinity 2-5C ccd digital camera attached to the trinocular head of a compound microscope; all microscopic measurements were obtained using Infinity Analyze software 6.5.2. All collections from New South Wales cited in 'Additional collections examined' were deposited in The Plant Pathology Herbarium, Orange Agricultural Institute, Orange, New South Wales, Australia (DAR) while those from Queensland were deposited in the Australian Tropical Herbarium, Cairns, Queensland, Australia (CNS). All holotype and isotype collections are deposited in the herbaria designated using acronyms from Thiers (2012).

DNA sequences and phylogenetic analyses

DNAs were extracted from silica-dried tissues according to Largent et al. (2011b). The nuclear large subunit ribosomal RNA (nrLSU) and the second largest subunit of the ribosomal RNA polymerase (RPB2) genes were PCR amplified following protocols described in prior publications (Largent et al. 2011a,b, 2013a,b). Partial mitochondrial small subunit ribosomal RNA (mtSSU) sequences were obtained using two different primer combinations: either 1) with MS1 and MS2 following White et al. (1990) or 2) by modifying the MS1 and MS2 primers to increase the success of PCR amplification (MS1-RhoF2, 5' to 3' – GTC AAT GCT CGM AAG AGT GAA CTA and MS2-RhoR1, 5' to 3' – ACA TGC TTC ACT YCG TTT GCT). The PCR protocol using the newly-developed primers is as follows: initial incubation at 94°C for 1 min, 39 cycles of 94°C for 1 min, 56°C for 1 min, 72°C for 1 min 30 sec, and a final temperature of 72°C for 7 min. Sequences were generated on an ABI3130xl following the sequencing and precipitation protocols in Largent et al. (2011b). After sequencing, forward and reverse sequences were edited and all ambiguities in chromatograms were visually confirmed using Sequencher 4.2.2 (Gene Codes Corp., Ann Arbor, MI).

TABLE 1. Collections used in the phylogenetic analyses.

New sequences generated for this study are shown in bold. Square bracketed annotations indicate species names applied in GenBank that differ from those in the phylogram (Fig. 1).

SPECIES	COLLECTION IDENTIFIER	GENBANK ACCESSION NO.		
		mtSSU	LSU	RPB2
<i>Alboleptonia angustospora</i> [= <i>A. aff. sericella</i>]	MCA1978	GU384583	GU384609	GU384632
<i>A. sericella</i>	DLL9524	KR869912	KR869940	KR869961
<i>A. stylophora</i>	DLL9805	KR869911	KR869939	KR869960
<i>Catathelasma imperiale</i>	11CA001A	KR869913	KR869941	KC816994
<i>Claudopus minutoincanus</i>	DLL9871	HQ731511	HQ731514	HQ731517
<i>C. parasiticus</i> [= <i>Entoloma parasiticum</i>]	20	GQ289317	GQ289177	GQ289248
	10617 TJB	KR233902	KR233872	KR233924
<i>Claudopus</i> sp.	DLL9735	KR869910	KR869938	KR869959
<i>C. viscosus</i>	DLL9788	HQ731513	HQ731516	HQ731518
<i>Clitocella fallax</i> [= <i>Rhodocybe fallax</i>]	25668OKM	KR869909	AF261283	KC816937
<i>Clitopilopsis hirneola</i> [= <i>Rhodocybe hirneola</i>]	REH8490	GU384587	GU384611	KC816904
<i>Clitopilus</i> aff. <i>hobsonii</i>	DLL9586	KJ021688	KJ021698	KC816912
<i>Cl. apalus</i>	26394WAT	KR869907	KR869936	KC816906
<i>Entocybe haastii</i> [= <i>Entocybe</i> sp.]	DLL10087	JQ793645	JQ793652	JQ793659
<i>Entoloma abortivum</i>	6693 TJB	GU384595	GU384616	GU384642
	5772 TJB	KR233897	KR233869	KR233926
<i>E. allochroum</i>	JVG 1060902-1	KC898488	KC898522	—
<i>E. caespitosum</i>	GDGM 27564	JQ993070	JQ320130	JQ993078
<i>E. callichroum</i> var. <i>venustum</i>	L Wo E17/10	KC898490	KC898523	—
<i>E. chytrophilum</i>	L Dahncke 855	KC898479	KC898519	—
	LE262994	KC898480	KC898520	—
<i>E. dichroum</i>	JVG 1070821-4	KC898486	KC898527	—
	LE234260	KC898487	KC898528	—
<i>E. discoloratum</i>	DLL10217	JQ793646	JQ793653	JQ793660
<i>E. euchroum</i>	LE262995	KC898483	KC898516	—
<i>E. eugenei</i>	LE253771	—	KC898529	—
	LE254347	—	KC898530	—
<i>E. ferruginans</i>	11CA032	KJ021689	KJ021699	KJ021693
<i>E. fragilum</i>	MCA2415	KJ021690	KJ021700	KJ021694
<i>E. indoviolaceum</i>	PM700	GQ289312	GQ289172	GQ289243
<i>E. lampropus</i>	LE262991	KC898470	KC898505	—
	UPS:F-176490	KC898471	KC898506	—
<i>E. lepidissimum</i>	LE254871	KC898493	KC898531	—
<i>E. myrmecophilum</i>	231	GQ289314	GQ289174	GQ289245
<i>E. nidorosum</i>	9971 TJB	GU384596	GU384617	GU384643
<i>E. pallideradicatum</i>	255	GQ289316	GQ289176	GQ289247
<i>E. pallidocarpum</i>	GDGM 28828	JQ993074	JQ410331	JQ993080
<i>E. percoelestinum</i>	LE254327	KC898496	KC898526	—

Continued on p. 156

TABLE 1, continued

SPECIES	COLLECTION IDENTIFIER	GENBANK ACCESSION NO.		
		mtSSU	LSU	RPB2
<i>E. placidum</i>	JVG1060830-6	KC898482	KC898515	—
<i>E. prunuloides</i>	40	GQ289324	GQ289184	GQ289255
<i>E. pygmaeopapillatum</i>	32	GQ289325	GQ289185	GQ289256
<i>E. readiae</i>	102	GQ289326	GQ289186	GQ289257
<i>E. rhodopolium</i>	8	GQ289327	GQ289187	GQ289258
<i>E. sublaevisporum</i>	LIP JVG 1070823T	KC898478	KC898518	—
<i>E. tectonica</i>	i15	GQ289336	GQ289196	GQ289266
<i>E. tjallingiorum</i> var. <i>alnetorum</i> [≡ <i>E. alnetorum</i>]	G00111402	KC898473	KC898508	—
<i>E. tjallingiorum</i> var. <i>laricinum</i>	LE254343	KC898477	KC898513	—
<i>E. tjallingiorum</i> var. <i>tjallingiorum</i>	UPS:F-016378	KC898474	KC898509	—
	LE254317	KC898475	KC898511	—
<i>E. transmutans</i>	155	GQ289340	GQ289200	GQ289268
<i>E. undatum</i>	18	GQ289342	GQ289202	GQ289270
<i>E. valdeumbonatum</i>	189	GQ289343	GQ289203	GQ289271
<i>E. vezzenaense</i>	241	GQ289344	GQ289204	GQ289272
<i>E. violaceotinctum</i>	DLL10088	JQ793643	JQ793650	JQ793657
<i>Inocephalus hypipamee</i>	DLL9981	JQ624603	JQ624608	KR869958
	DLL10071	JQ624604	JQ624609	JQ624616
“ <i>I. lactifluus</i> ”	7962 TJB	—	AF261304	—
<i>I. luteus</i>	6562 TJB	—	KR869944	—
<i>I. plicatus</i>	DLL9691	JQ624605	JQ624610	JQ624617
<i>I. virescens</i>	DLL9972	KR869908	KR869937	KR869957
<i>Lepista nuda</i>	11CA041	KJ021692	KJ021705	KJ136110
<i>Leptonia ambigua</i>	DLL9872	JQ756399	JQ756414	JQ756429
<i>L. boardinghousensis</i>	DLL10086	JQ756398	JQ756413	JQ756428
<i>L. coelestina</i> [≡ <i>Entoloma coelestinum</i>]	LE258103	KC898494	KC898524	—
<i>L. decolorans</i>	DLL9533	KR233883	KR233852	KR233914
<i>L. exilis</i>	DLL9530	KR869906	KR869935	KR869956
<i>L. newlingii</i>	DLL10004	KR869897	KR869926	—
	DLL10026	KR869898	KR869927	KR869951
<i>L. odorifera</i>	6534 TJB	KR233899	KR233870	KR233927
<i>L. omphalinoides</i>	DLL9800	JQ756401	JQ756417	JQ756432
<i>L. poliopus</i>	DLL10209a	JQ756402	JQ756418	JQ756433
<i>L. sabulosa</i>	DLL10058	KR869895	KR869924	KR869950
	DLL10427	KR869896	KR869925	—
<i>L. subpanniculus</i>	DLL9647	KR869891	KR869919	KR869946
	DLL9668	KR869892	KR869921	KR869947
	DLL9697	KR869893	KR869922	KR869948
	DLL10070	KR869889	KR869917	—
	DLL10227	—	KR869920	—
	DLL10260	KR869890	KR869918	—
<i>L. substricta</i>	DLL9852	KR869894	KR869923	KR869949

TABLE 1, cooncluded

SPECIES	COLLECTION IDENTIFIER	GENBANK ACCESSION No.		
		mtSSU	LSU	RPB2
<i>L. trichomata</i>	11CA006	KR233873	KR233840	KR233903
<i>L. umbraphila</i>	DLL9640	JQ756407	JQ756422	JQ756438
	DLL9766	JQ756408	JQ756423	JQ756439
<i>Mycena</i> aff. <i>pura</i>	11CA007	KR869914	KR869942	KC816995
<i>Nolanea bicoloripes</i>	DLL9532	KR869904	KR869933	KR869954
<i>N. cetrata</i>	DLL9531	KF738927	KF738942	KF771346
<i>N. cf. conferenda</i>	11CA014	KF738935	KF738946	KF771351
<i>N. conferenda</i> [= <i>Entoloma conferendum</i>]	6	GQ289300	GQ289160	GQ289231
<i>N. hebes</i> [= <i>Entoloma hebes</i>]	46	GQ289310	GQ289170	GQ289241
<i>N. hirtipes</i>	DLL9525	KR869905	KR869934	KR869955
<i>N. rigidipes</i>	DLL9528	KR869902	KR869932	KR869953
<i>N. sericea</i>	DLL9527	KR233882	KR233851	KR233913
	11CA055	KF738933	KF738944	KF771349
<i>Nolanea</i> sp.	DLL9976	KR869903	KR869931	KR869952
<i>N. strictior</i> var. <i>isabellina</i> [= <i>Entoloma. strictius</i> var. <i>isabellinum</i>]	7710 TJB	GU384594	GU384618	GU384641
<i>Panellus stipticus</i>	11CA052	KR869915	KR869943	KC816996
<i>Pouzarella farinosa</i>	DLL9934	HQ876538	HQ876516	HQ876495
<i>P. lasia</i>	DLL9662	HQ876551	HQ876529	HQ876507
<i>P. pamiae</i>	DLL9794	HQ876539	HQ876517	HQ876496
<i>P. pilocystidiata</i>	DLL9848	HQ876542	HQ876520	HQ876499
<i>Rhodocybe pruinosostipitata</i>	MCA1492	GU384608	GU384627	GU384653
<i>R. roseiavellanea</i>	8130 TJB	KR869901	KR869930	KC816982
<i>R. spongiosa</i>	MCA2129	GU384604	GU384628	GU384657
<i>Rhodophana nitellina</i>	7861 TJB	KR869900	KR869929	KC816959
<i>Tricholoma flavovirens</i>	11CA038	KJ021691	KJ021704	KC816997
<i>Trichopilus porphyrophaeus</i>	6957 TJB	—	AF261290	—

A total of 281 sequences (fifty-nine newly generated for this study and 222 obtained from GenBank) were used to infer phylogenetic relationships (TABLE 1). Sequences were aligned with MAFFT v. 7 (default settings) and manually adjusted using Mesquite 2.75 (Mesquite Software Inc., Austin, TX). Intronic regions in the RPB2 and hyper-variable regions and large introns in the mtSSU were excised before analyses. Aligned sequences were 1,078 bp (nrLSU), 585 bp (mtSSU), and 1501 bp (RPB2), and six mtSSU and 28 RPB2 sequences were coded as missing data (TABLE 1). A Maximum Likelihood (ML) analysis with 1000 replicates and specifying a GTRGAMMA model in RAXML-HPC2 XSEDE 8.0.24 (Stamatakis 2006) using the CIPRES Science Gateway 3.1 (Miller et al. 2010) was conducted on a concatenated alignment of the three gene regions. Each gene region was partitioned separately and the RPB2 region was partitioned across all codon positions for a total of five partitions in the dataset. Supports for branches were generated using 1000 bootstrap (BS) iterations, and BS support values ≥ 70 were considered significant.

Results & discussion

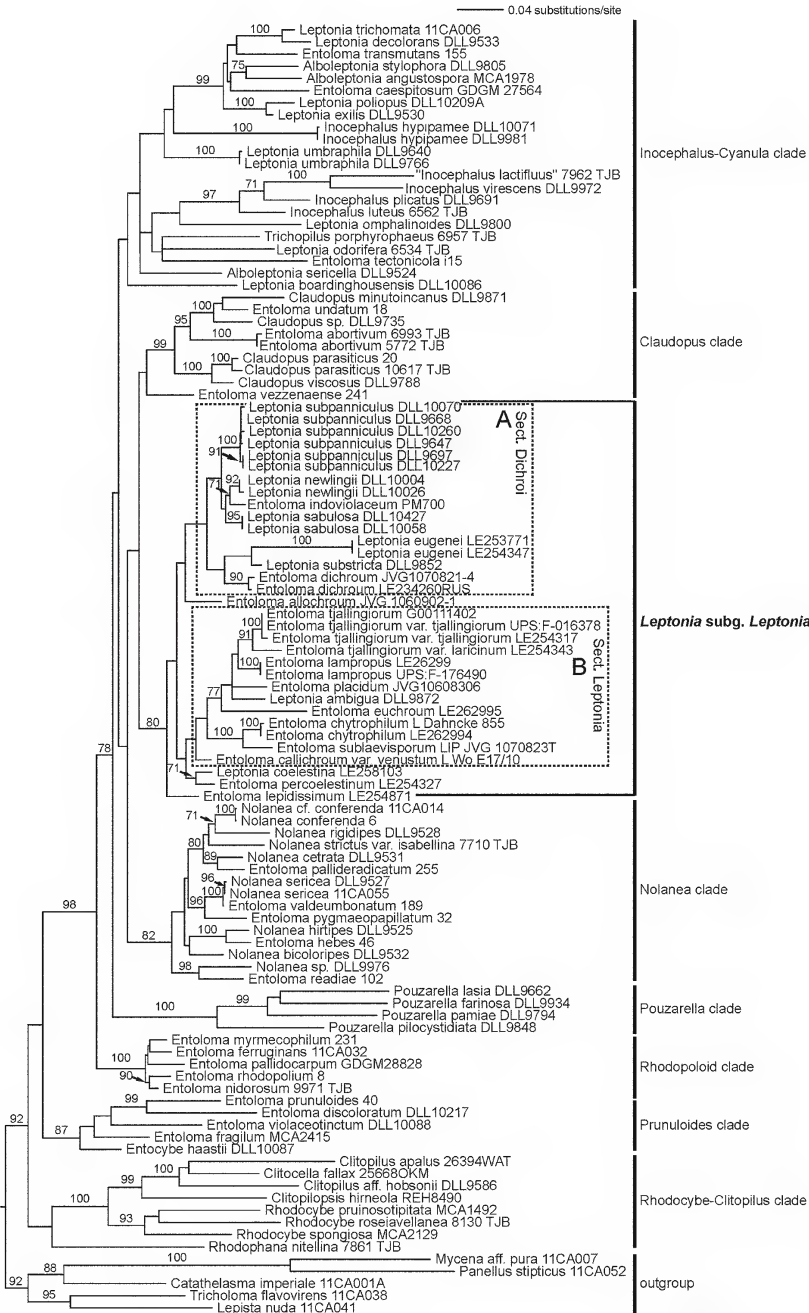
Our ML phylogenetic analysis (FIG. 1) statistically supports (BS = 80) monophyly of *Leptonia* subg. *Leptonia* ($\equiv$ *Entoloma* subg. *Leptonia*) and separates the *Leptonia* clade from other entolomatoid clades: *Inocephalus*-*Cyanula*, *Claudopus*, *Nolanea*, *Pouzarella*, *Prunuloides*, *Rhodopoloid*, and *Rhodocybe*-*Clitopilus* as previously demonstrated by Morozova et al. (2014). Within the *Leptonia* clade, Morozova et al. (2014) identified two subclades that correspond taxonomically to *Entoloma* sect. *Dichroi* O.V. Morozova et al. and *E.* sect. *Leptonia* as well as a number of species with unknown affinity to either section. Our analysis does not support the monophyly of these sections (FIG. 1: boxes A, B). Our results support the four new species described here, *L. ambigua* from Australia (Largent et al. 2013b), *E. indoviolaceum* Manim. & Noordel. from India, and the Eurasian species described by Morozova et al. (2014) all within *L.* subg. *Leptonia*.

Leptonia newlingii, *L. sabulosa*, and *L. subpanniculus* from Australia, *Entoloma indoviolaceum* from India, *E. dichroum* (Pers.) P. Kumm. from eastern and western Europe, *E. eugenei* Noordel. & O.V. Morozova from Russia, and *L. substricta* from Australia (FIG. 1: box A) all have violet or blue-black basidiomata and basidiospores with 5–7 more or less acute angles (PLATES. 2F, 4E, 6D, 8C). Although these seven species collectively resemble *E.* sect. *Dichroi* sensu Morozova et al. (2014), a phylogenetic relationship is not statistically supported (FIG. 1). Our analysis supports only one phylogenetic relationship for these species, with *L. newlingii* and *E. indoviolaceum* the most closely related (BS = 71, FIG. 1).

These seven species cluster into two groups—one with *Leptonia newlingii*, *L. sabulosa*, *L. subpanniculus*, and *Entoloma indoviolaceum* and the other with *E. dichroum*, *E. eugenei*, and *L. substricta*. However this clustering pattern was not statistically supported (FIG. 1). Within the two groups, the species have morphologically similar basidiospores. The group containing *L. sabulosa* has basidiospores that are distinctly angular but slightly rounded or with very slightly protruding angles, contrasting with the acutely angled basidiospores of *E. dichroum*, *E. eugenei*, and *L. substricta* that lack protruding angles.

Our analysis also places *L. ambigua* in a sub-clade with *E. euchroum* ($\equiv$ *L. euchroa*), *E. lampropus* (Fr.) Hesler, *E. placidum* (Fr.) Noordel., *E. tjallingiorum* var. *alnetorum* (Monthoux & Röllin) O.V. Morozova et al.,

FIGURE 1. Topology of the maximum-likelihood phylogram showing branches with statistical supports $\geq 70\%$ based on 1000 bootstrap replicates. Shaded species highlight the species from Australia described in this report. The labeled boxes show (A) *Entoloma* sect. *Dichroi* and (B) *E.* sect. *Leptonia* as defined by Morozova et al. (2014)—see also Results & discussion.



E. tjallingiorum var. *laricinum* O.V. Morozova et al., and *E. tjallingiorum* Noordel. var. *tjallingiorum* (BS = 77, FIG. 1). All these species have obscurely angled basidiospores and dark violet to blue-black squamulose pilei that become brown.

Taxonomy

***Leptonia subpanniculus* Largent & Bergemann, sp. nov.**

PLATES 1, 2

MYCOBANK MB 813877

Differs from *Entoloma panniculus* by its dark purplish violet colors, mild and not distinctive taste and odor, and larger basidiospores.

TYPE — Australia, Queensland, Cook Region, Mt. Hypipamee National Park 17°25'35"S 145°29'16"E, in soil protected by roots, 9 March 2012, DL Largent 10260 (holotype BRI; isotype CNS; GenBank KR869890 (mtSSU), KR869918 (LSU)).

ETYMOLOGY — named for the similarity to *E. panniculus*.

BASIDIOMATA mycenoid to collybioid. **PILEUS** 10–38 mm broad, 5–13 mm high, at first conic, conic-campanulate, or campanulate (but not umbonate), expanding to broadly campanulate and umbonate to broadly convex with an obscure umbo, eventually convex without an umbo; when young covered entirely with minute erect dark purplish violet (17 or 18F6–7) squamules that with pileal expansion remain erect at the center and becoming semi-erect to appressed from margin to the edge; the squamules remaining dark purplish violet at the tips but becoming dark grayish violet (18E6) elsewhere and greyish violet (17C-D4–5) at the edge; the surface always dull and opaque, neither hyrophanous nor translucent-striate; the edge fibrillose, typically extending 1–1.5 mm beyond the lamellae, decurved then plane, even then eroded to crenulate. **CONTEXT** 1.0–1.5 mm thick above stipe, 0.5 mm thick at the edge; violaceous (17F4). **ODOR** not distinctive, mild. **TASTE** not distinctive at first, later slowly becoming pungent. **LAMELLAE** 6–18 mm long, 2–9 mm broad; yellowish white to pale yellow when young, becoming grayish orange (5B3) from basidiospores, edges concolorous; sinuate, subdistant, sigmoid and narrow at first, becoming moderately broad, eventually broad in larger basidiomata; edges smooth. **STIPE** 10–61 mm long and width 2–3 mm at apex, 2–4 mm in middle, and 2–9 mm at base; rarely equal, typically clavate; ± solid and stuffed but not fragile; apex either white and glabrous or (when young) entirely covered with dark purplish violet (17 or 18F6–7) dense fibrils and punctate-squamules; when mature rimulose with dense fibrils and scattered punctae forming darker reticulate ridges around grayish violet fibrillose gaps; basal tomentum scarce to absent; basal rhizoids absent. **VEIL** possibly present as indicated by the fibrils on the otherwise white stipe apex and the purplish violet fibrils on the crenulate pileal edge.

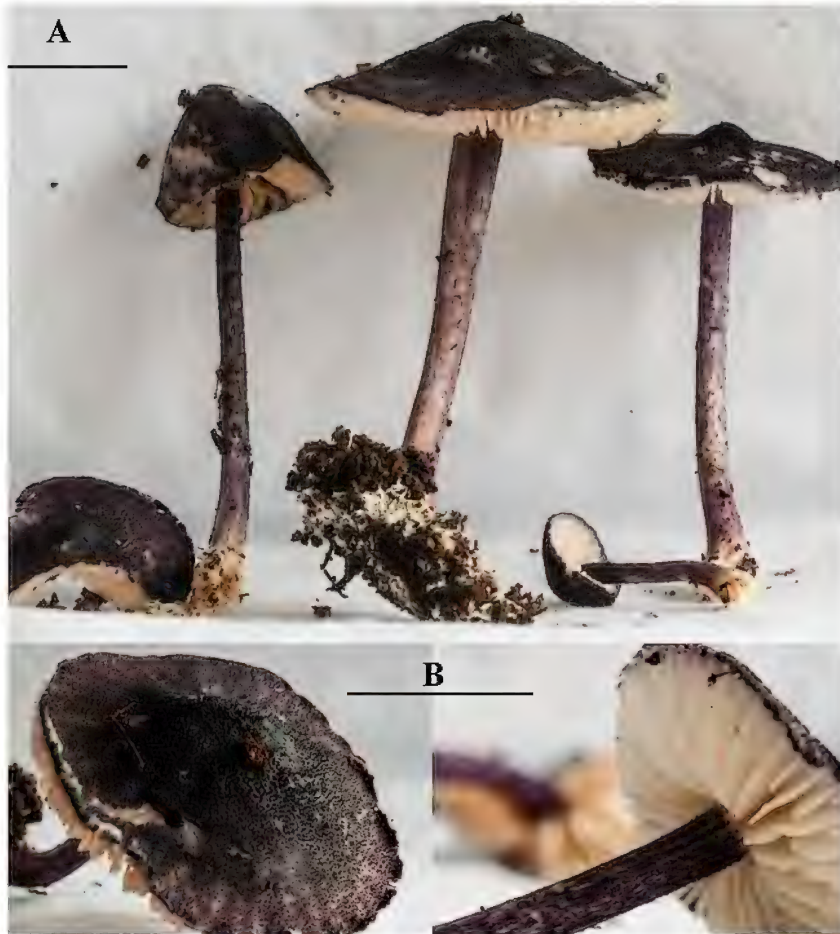


PLATE 1. *Leptonia subpanniculus* (DLL10260 holotype): A. basidiomata; B. pileus surface (left), stipe surface, and lamellae (right): Bars = 14 mm.

BASIDIOSPORES 5–7 distinct angles, at times the angles slightly more pronounced and protuberate, in profile view isodiametric to heterodiametric, on average heterodiametric, apex typically rounded-triangular, rarely truncate, frequently with a suprahilar depression just above the adaxial side of the hilar appendage; $9.2\text{--}13.4 \times 6.0\text{--}9.5 \mu\text{m}$ ($x = 11.1 \pm 0.9 \times 7.7 \pm 0.6 \mu\text{m}$; $E = 1.1\text{--}1.8$; $Q = 1.44 \pm 0.1$; $n/11 = 242$). BASIDIA 2–4-sterigmate, subclavate and somewhat tapered to the base, $31\text{--}54 \times 10\text{--}17 \mu\text{m}$ ($x = 43.3 \pm 3.9 \times 12.4 \pm 2.9 \mu\text{m}$;

E = 2.4–4.8; Q = 3.44 ± 0.6 ; n/3 = 25). LAMELLAR EDGE fertile. CHEILOCYSTIDIA absent. PLEUROCYSTIDIA absent. LAMELLAR HYPHAE subparallel, $99\text{--}159 \times 6\text{--}13 \mu\text{m}$ (n/1 = 6). PILEIPELLIS from $100\text{--}300 \mu\text{m}$ thick, in young basidiomata the hyphae typically entangled along the entire surface with the terminal 2–5 cells forming a distinct trichodermium, in older basidiomata a trichodermium on the disc, forming semi-erect clusters towards the margin and forming a periclinal layer of entangled hyphae at the edge. PILEOCYSTIDIA cylindric to cylindro-clavate; typically long, $62\text{--}233 \times 9\text{--}16 \mu\text{m}$ ($x = 123.6 \pm 49.78 \times 11.1 \pm 2.1 \mu\text{m}$; E = 5.5–17.3; Q = 11 ± 3.3 ; n/2 = 15). PILEUS TRAMA hyphae subparallel in radial section, $179\text{--}298 \times 8\text{--}15 \mu\text{m}$ (n/1 = 3). STIPITIPPELLIS similar to the pileipellis along the entire length, but forming a cutis at the apex. CAULOCYSTIDIA similar to the pileocystidia, $48\text{--}204 \times 6\text{--}11 \mu\text{m}$ (n/2 = 15). STIPE TRAMAL HYPHAE subparallel, $200\text{--}367 \times 6.0\text{--}12.9 \mu\text{m}$ (n/1 = 4). OLEIFEROUS HYPHAE rare to absent in the trama. BRILLIANT GRANULES typically absent but at times very scattered in basidia. LIPOID GLOBULES absent. PIGMENTS in the suprapellis hyphae cytoplasmic and brownish to purplish, in the hyphae of the subpellis and outer pileal trama both cytoplasmic and purplish as well as encrusted and dark brownish; pigments eventually producing a purplish grey exudate in water, 10% NH_4OH , and 3% KOH. CLAMP CONNECTIONS abundant in all tissues.

ECOLOGY & DISTRIBUTION — Solitary or scattered in soft crumbly soil at the bottom of a moss-covered depression or along a path in soil protected by roots in a closed canopy forest just above the falls in Mt. Hypipamee National Park or within moss-covered trenches in open canopy in Longlands State Forest, mid to late March.

ADDITIONAL COLLECTIONS EXAMINED — AUSTRALIA. QUEENSLAND, Cook Region, Mt. Hypipamee National Park, $17^\circ 25' 35''\text{S}$ $145^\circ 29' 12''\text{E}$, 14 March 2009, DL Largent 9647; 18 March 2009, DL Largent 9668; $17^\circ 25' 35''\text{S}$ $145^\circ 29' 16''\text{E}$, 17 March 2011, DL Largent 10034; $17^\circ 25' 35''\text{S}$ $145^\circ 29' 15''\text{E}$, 25 March 2011, DL Largent 10070; $17^\circ 25' 35''\text{S}$ $145^\circ 29' 17''\text{E}$, 14 March 2012, DL Largent 10282; $17^\circ 25' 37''\text{S}$ $145^\circ 29' 15''\text{E}$, 20 March 2012, DL Largent 10306; Herberton National Park, Longlands Gap State Forest, $17^\circ 27' 07''\text{S}$ $145^\circ 28' 33''\text{E}$, 24 March 2009, DL Largent 9697; $17^\circ 27' 17''\text{S}$ $145^\circ 28' 33''\text{E}$, 1 March 2012, DL Largent 10227; 10 March 2012, DL Largent 10266; $17^\circ 27' 16''\text{S}$ $145^\circ 28' 34''\text{E}$, 14 March 2012, DL Largent 10285.

DISTINCTIVE CHARACTERS—Mycenoid to collybioid, purplish violet basidiomata with a possible veil, stipe typically developing reticulate or punctate ridges in age; basidiospores heterodiametric, averaging $11 \times 8 \mu\text{m}$, distinctly angular (occasionally with slightly protuberant angles), apex in profile view often rounded or truncate and with an adaxial depression, suprapellis with cytoplasmic brownish (occasionally purplish) pigments, and the subpellis with both cytoplasmic purplish and encrusting dark brownish pigments.



PLATE 2. *Leptonia subpanniculus* (DLL10260 holotype): A. stipitipellis longitudinal section at apex; B. pileipellis radial section near disc; C. cylindro-clavate and narrowly obclavate pileocystidia (terminal cells); D. pileipellis subpellis and outer pileal trama; encrusted and cytoplasmic pigment; and clamp; E. basidia and basidioles; F. basidiospores. Bars: A = 60 μm ; B = 50 μm ; C, E = 12 μm ; D = 15 μm ; F = 8 μm .

COMMENTS—*L. subpanniculus* is morphologically very similar to *Entoloma panniculus* (Berk.) Sacc. from Tasmania, which differs in its deep blue coloration, farinaceous odor, oily taste, and basidiospore size ($9\text{--}12 \times 6\text{--}8 \mu\text{m}$) (Noordeloos & Gates 2012).

***Leptonia substricta* Largent & Bergemann, sp. nov.**

PLATES 3, 4

MYCOBANK MB 813880

Differs from *Entoloma strictum* by its mycenoid basidiomata with yellowish white to pale yellow adnexed lamellae, mild taste and odor, and obclavate caulocystidia.

TYPE — Australia, New South Wales, central Hunter District, Myall Lakes National Park, 32°32'30"S 152°18'39"E, in sandy soil, 10 April 2010, DL Largent 9852 (**holotype** DAR; GenBank KR869894 (mtSSU), KR869923 (LSU), KR869949 (RPB2)).

ETYMOLOGY — named for its similarity to *E. strictum*.

BASIDIOMATA mycenoid. PILEUS 10–20 mm broad, 8–15 mm high, at first evenly conic to campanulate, in age convex and obscurely umbonate, edge decurved, even when young, becoming crenulate in age; surface matted squamulose becoming matted fibrillose towards the edge; indigo-blue (18F3) to dark violet (18F6) with the squamule tips more blackish purple; opaque, neither translucent nor hygrophanous. CONTEXT 0.5–1.0 mm. above the stipe. ODOR & TASTE mild. LAMELLAE 8–9 mm long, 3–4 mm broad, adnexed, narrow to moderately wide, close to subdistant, edges eroded in age; bluish white at first, then yellowish white (4A2–3) to pale yellow (4A3), becoming orangish white (5A2–3) as spores mature; where injured becoming brownish; edges concolorous. LAMELLULAE typically in 3 (rarely 4) series, 1–2 short, 1 medium, and 1 medium long. STIPE 40–90 × 2–3 mm, equal; solid but fragile and snaps easily; surface at times longitudinally furrowed, densely appressed fibrillose-squamulose; blackish blue (19F6), squamules with purplish black punctate tips abundant at the apex, moderately abundant to scarce in the middle, and very scattered to nearly absent at the base; base with abundant to copious whitish blue tomentum, occasionally also with rhizoids projecting 10–20 mm into the soil.

BASIDIOSPORES 5–7 distinct angles, in profile subisodiametric to heterodiametric (on average heterodiametric), apex typically rounded, rarely truncate; 8–12 × 6–10 µm ($x = 10.5 \pm 0.9 \times 7.7 \pm 0.8$ µm; $E = 1.1$ – 1.7 ; $Q = 1.38 \pm 0.14$; $n/2 = 59$). BASIDIA 4-sterigmate, clavate, broad, 28–50 × 7–14 µm ($x = 41.1 \pm 8.5 \times 11 \pm 2.3$ µm; $E = 3.4$ – 4.1 ; $Q = 3.71 \pm 0.28$; $n/2 = 9$). LAMELLAR EDGE fertile. CHEILOCYSTIDIA absent. PLEUROCISTIDIA absent. LAMELLAR TRAMAL HYPHAE subparallel, short to moderately long, 34–192 × 6.5–14 µm ($x = 113 \pm 47 \times 10 \pm 2.6$ µm; $E = 4$ – 19 ; $Q = 11.7 \pm 5.0$; $n/2 = 9$). PILEIPELLIS at first a trichodermium over the entire surface, 150–300 µm deep, composed of 3–5 cells with the pileocystidia erect and the subterminal cells longitudinally entangled, remaining so with age on central 2/3 but becoming semi-erect towards the margin and nearly prostrate at the edge. PILEOCYSTIDIA versiform (clavate to cylindro-clavate, subulate to obclavate), 46–100 × 7–19.5 µm ($x = 74.6 \pm 15.9 \times 12.6 \pm 4.1$ µm; $E = 3$ – 11 ; $Q = 6.6 \pm 2.6$; $n/2 = 21$). PILEAL TRAMAL HYPHAE subparallel 58–226 × 4–22 µm ($x = 119 \pm 63 \times 12.1 \pm 6.3$ µm; $E = 4$ – 52 ; $Q = 14.2 \pm 16.8$; $n/2 = 7$). STIPITPELLIS composed of clusters of erect to semi-erect 2–5 celled-hyphae separated by a 2–3-celled prostrate cutis; terminal cells differentiated. CAULOCYSTIDIA similar in shape but often much



PLATE 3. *Leptonia substricta* (DLL 9852 holotype): basidiomata. Bar = 10 mm.

longer than the pileocystidia, $48\text{--}156 \times 6\text{--}13\text{ }\mu\text{m}$ ($x = 81.8 \pm 35.8 \times 9.2 \pm 1.7\text{ }\mu\text{m}$; $E = 4\text{--}19$; $Q = 9.2 \pm 4.4$; $n/2 = 13$). STIPE TRAMAL HYPHAE subparallel, $200\text{--}367 \times 6.0\text{--}13\text{ }\mu\text{m}$; $n/2 = 9$). OLEIFEROUS HYPHAE rare in the lamellar trama, absent elsewhere. BRILLIANT GRANULES absent. LIPOID GLOBULES absent. PIGMENTS in pilei-/stipitipellis brownish blue, cytoplasmic; in pileus subpellis dark brown, encrusting. CLAMP CONNECTIONS in all tissues.

ECOLOGY & DISTRIBUTION—Barrington Tops National Park: scattered, humicolous, subtropical gallery rainforest, mid-March; Mungo Brush, Myall

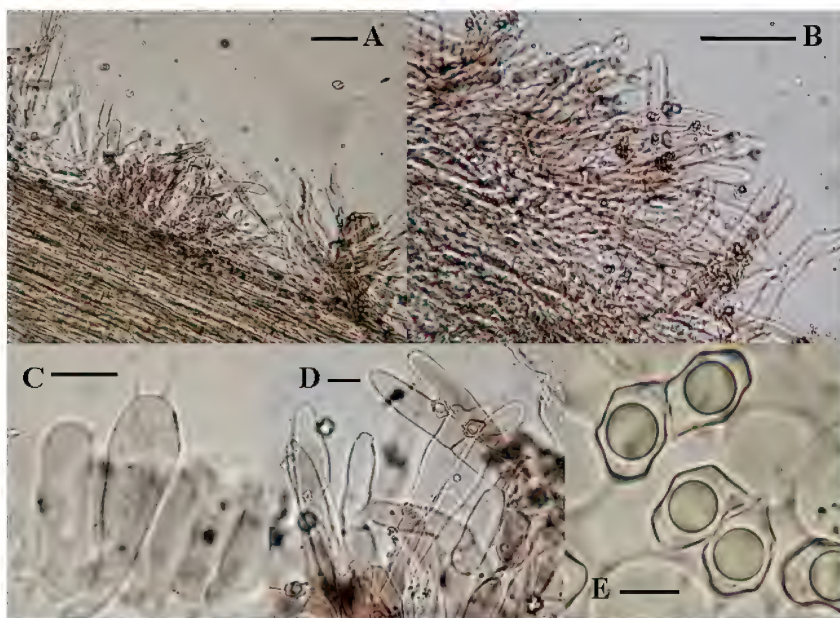


PLATE 4. *Leptonia substricta* (DLL 9852 holotype): A. stipitipellis longitudinal section at apex; B. pileipellis radial section near disc; C. basidia and basidioles; D. broadly obclavate pileocystidia and cytoplasmic pigment; E. basidiospores. Bars: A = 125 μ m; B = 50 μ m; C = 9 μ m; D, E = 7 μ m.

Lakes National Park: exposed in sandy soil along the trail in a littoral rainforest, early April.

ADDITIONAL COLLECTION EXAMINED —AUSTRALIA. NEW SOUTH WALES, central Hunter District. Barrington Tops National Park, Williams Day Use Area, 16 March 2009, S Moore l.

DISTINCTIVE CHARACTERS—Basidiomata mycenoid; pileus conic to campanulate, appressed squamulose then matted squamulose to matted fibrillose towards edge, indigo-blue to dark violet (18F6) with the squamule-tips more blackish purple; stipe long and narrow, very fragile, blackish blue and densely appressed fibrillose but with abundant to scarce purplish black-tipped squamules; lamellar edge fertile; pileocystidia subulate to obclavate; Pilei-/stipitipellis with brownish blue cytoplasmic pigments, pileus subpellis with encrusting pigments; taste and odor mild.

COMMENTS—*Leptonia substricta* morphologically resembles *Entoloma strictum* G. Stev. (Horak 2008), which differs by its collybioid basidiomata, (arcuate)

decurrent pink lamellae, farinaceous taste and odor, and clavate or vesiculose caulocystidia. *Entoloma cedretorum* (Romagn. & Rioussel) Noordel., from southern France and Morocco, also close to *L. substricta*, differs in its white lamellae, entirely wooly-tomentose stipe, and intracellular pigment.

***Leptonia sabulosa* Largent & Bergemann, sp. nov.**

PLATES 5, 6

MYCOBANK MB 813883

Differs from *Entoloma endotum* by its yellowish young lamellae, punctuate squamulose stipe, mild taste, sandy habitat, and smaller basidiospores.

TYPE — Australia, New South Wales, central Hunter District, Tomaree National Park, 32°45'26"S 152°08'03"E, in sandy soil, 23 April 2012, DL Largent 10427 (holotype DAR, GenBank KR869896 (mtSSU), KR869925 (LSU)).

ETYMOLOGY — derived from the Latin *sabulosus* referring to the fruiting in sandy soil.

BASIDIOMATA tricholomatoid. PILEUS 27–64 mm broad, 7–12 mm high; when young convex to broadly convex (not umbonate), expanding to plane and broadly umbonate; at first uniformly appressed squamulose with flat overlapping squamules that later collapse to form a uniformly velvet-like surface; dull (neither translucent nor hygrophanous), center dark blackish blue with a dark violet tint (18–19F5–7), somewhat lighter (18–19E5–7) towards the margin, still lighter (18E5–8) on the very edge; outer margin incurved at first,



PLATE 5. *Leptonia sabulosa* (DLL10427 holotype): basidiomata. Bar = 25 mm.

becoming decurved, then plane and eventually uplifted, the edge extending beyond the lamellae by 1 mm. CONTEXT 2–5 mm thick above the stipe, solid, watery grey. ODOR somewhat pungent. TASTE mild. LAMELLAE 13–25 mm long, 5–10 mm broad; sinuate, close to subdistant, moderately wide to wide, edges smooth; initially yellowish white to orange-white (4–5A2), becoming orange-white to grayish orange (5A–B2–3) from spores with concolorous edges. LAMELLULAE in 3 tiers between lamellae, 2 short and 1 longer. STIPE 37–75 mm long, 5–9 mm thick at apex and middle, 7–12 mm thick at base; stuffed at first becoming hollow at the apex; overall densely fibrillose with the fibrils splitting laterally and with abundant black-edged punctae from apex to base (at the very base rare in some), at the base tomentum abundant, forming a broad pad; blackish-blue (19F7–8) when young (becoming more greyish violet (18–19E5) as the fibrils split apart), dark blue (19E6) at the base; basal tomentum staining orangish (4A2–3).

BASIDIOSPORES 5–7 distinct angles (at times slightly more pronounced and protuberate), in profile subisodiametric to heterodiametric (on average decidedly heterodiametric, only rarely isodiametric), the apex typically rounded, rarely truncate; $8\text{--}13 \times 6\text{--}9 \mu\text{m}$ ($x = 10.4 \pm 0.8 \times 7.0 \pm 0.6 \mu\text{m}$; $E = 1.1\text{--}1.8$; $Q = 1.5 \pm 0.1$; $n/3 = 100$). BASIDIA 4-sterigmate, clavate, $37\text{--}54 \times 6.5\text{--}13.5 \mu\text{m}$ ($x = 45.1 \pm 5.1 \times 11.0 \pm 1.4 \mu\text{m}$; $E = 3\text{--}8$; $Q = 4.2 \pm 0.9$; $n/3 = 27$). LAMELLAR EDGE fertile. CHEILOCYSTIDIA absent. PLEUROCISTIDIA absent. LAMELLAR TRAMAL HYPHAE subparallel, $46\text{--}135 \times 5\text{--}23 \mu\text{m}$ ($x = 83.0 \pm 29.1 \times 12.8 \pm 6.8 \mu\text{m}$; $E = 2\text{--}17$; $Q = 8.3 \pm 4.8$; $n/1 = 12$). PILEIPELLIS 122–321 μm deep, a $\pm$ erect entangled layer of 3–6-celled hyphae; PILEOCYSTIDIA cylindro-clavate to broadly cylindro-clavate and often cystidiiform, $43\text{--}128 \times 5\text{--}17 \mu\text{m}$ ($x = 80.5 \pm 21.9 \times 11.4 \pm 3.0 \mu\text{m}$; $E = 2\text{--}16$; $Q = 7.8 \pm 3.6$; $n/2 = 30$). PILEAL TRAMAL HYPHAE entangled, 13–28 μm wide ($n/1 = 7$). STIPITIPELLIS a layer of hyphae 4–6-cells deep, composed of abundant clusters of semi-erect to erect anticlinal hyphae interspersed among periclinal hyphae. CAULOCYSTIDIA cylindro-clavate, $51\text{--}86 \times 7\text{--}13 \mu\text{m}$ ($x = 74.5 \pm 13.5 \times 10.0 \pm 2.6 \mu\text{m}$; $E = 5\text{--}12.5$; $Q = 7.9 \pm 2.6$; $n/2 = 10$). STIPE TRAMAL HYPHAE 8–28 μm diam ($n/1 = 7$). OLEIFEROUS HYPHAE absent. BRILLIANT GRANULES scattered in the basidia. LIPOID BODIES absent. PIGMENTATION purplish blue, cytoplasmic in the pileipellis and stipitipellis. CLAMP CONNECTIONS abundant in all tissues.

ECOLOGY & DISTRIBUTION—Scattered in sandy soil and leaves in the forest between the beach and mangrove stands in northeastern Queensland, late March; also beneath grass trees (species of *Xanthorrhoea* Sm.) and cycads (species of *Macrozamia* Miq.) in central New South Wales, April.

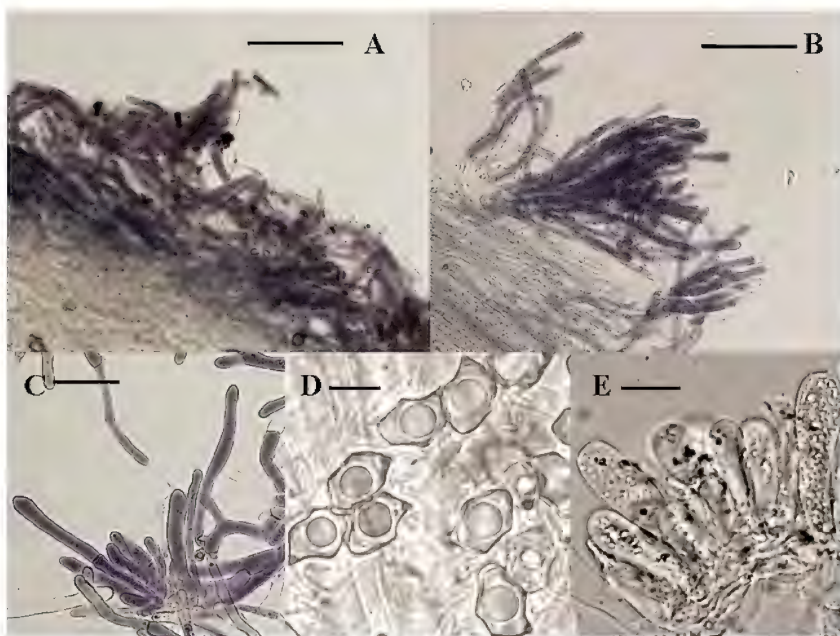


PLATE 6. *Leptonia sabulosa* (DLL10427 holotype): A. pileipellis radial section near disc; B. stipitipellis longitudinal section at apex; C. cylindro-clavate pileocystidia (terminal cells); D. basidiospores; E. basidia and basidioles. Bars: A, B = 50 μ m; C = 80 μ m; D = 7 μ m; E = 11 μ m.

ADDITIONAL COLLECTIONS EXAMINED —AUSTRALIA. QUEENSLAND, Cook Region, Yorkies Knob 16°49'01"S 145°43'50"E, 21 March 2011, DL Largent 10058. NEW SOUTH WALES, central Hunter District, Wyrribalong National Park, 33°17'40"S 151°32'38.20"E, P O'Sullivan NW 010; Tomaree National Park, 32°45'26"S 152°08'02"E, 24 April 2012, DL Largent 10445.

DISTINCTIVE CHARACTERS—Basidiomata tricholomatoid; pileus dark blackish blue with a dark violet tint; appressed squamulose pileus becoming velvety in age; young yellowish tinged lamellae developing a decidedly grayish orange cast when mature; cheilocystidia absent; basidiospores with slightly protuberant angles; odor pungent, taste mild.

COMMENTS—*Entoloma endotum* Noordel. & G.M. Gates from Tasmania is distinguished from *L. sabulosa* by its creamy pink young lamellae, fibrillose-floccose or girdled stipe, a salty or bitter to acrid taste, and somewhat larger basidiospores (10.5–12.7 $\times$ 7.9–8.5 μ m). *Entoloma eugenei* differs by its sterile lamellar edges, pure white lamellae, blackish blue colors (violet tinted in the

pileus), cylindrical, lageniform, or irregularly shaped cheilocystidia, and strangulated pilei- and caulocystidia.

Leptonia newlingii Largent & Bergemann, **sp. nov.**

PLATES 7, 8

MYCOBANK MB 813886

Differs from *Entoloma indoviolaceum* by its medium to large basidiomata, fertile lamellar edges, slightly shorter basidiospores, and the cytoplasmic pigments in both pilei- and stipitipellis.

TYPE — Australia, Queensland, Cook Region, Yorkies Knob Beach Forest, 16°48'59"S 145°43'49"E, in sandy soil, 11 March 2011, DL Largent 10004 (holotype BRI; isotype CNS; GenBank KR869897 (mtSSU), KR869926 (LSU)).

ETYMOLOGY — named for Peter Newling, who discovered it.

PILEUS 11–51 × 5–18 mm, initially convex to campanulate (not umbonate), then plane to uplifted and broadly umbonate; entirely punctate tomentose from blunt erect pointed scales that flatten to form a uniformly appressed velvety surface; dull, opaque but not translucent; blackish blue (19F5) when young, becoming slightly lighter (19F4) on the disc and somewhat lighter (19E4) elsewhere; the outer margin incurved then decurved to plane, the edge in age crenulate to eroded, extending past lamellae by 0.5–1 mm. CONTEXT 0.5–2 mm thick above the stipe, violaceous to bluish white. ODOR mild. TASTE mild (occasionally somewhat pungent to farinaceous). LAMELLAE 7–25 × 2.5–8 mm; adnexed to nearly adnate; at first close and narrow, then subdistant and moderately broad to broad with smooth then eroded edges; initially pale yellow (2A3) to yellowish white (4A2), becoming pale orange (5A3) as spores mature, with concolorous edges. LAMELLULAE in 1 or 3 series, 1 medium or 2 short (≤ 3 mm) and 1 medium (≤ 11 mm). STIPE 42–73 mm long, the 2–7 mm diam. apex expanding to 7–15 mm base; at first apex punctate from erect squamules, elsewhere densely fibrillose-squamulose, later remaining punctate at the apex but becoming rimose and longitudinally reticulate-ridged elsewhere with the ridges composed of fibrils interspersed with appressed squamules; at first blackish blue (20F6), with the ridges lightening slightly (20D4), and then finally dark blue (19E4); context stuffed then hollow, more or less yellowish orange with a hint of orange (4–5A3); stipe base with scarce to moderately abundant white (at times yellowish white, 2A2) tomentum and abundant yellowish white rhizoids spreading into the soil.

BASIDIOSPORES 5–7 distinct to rounded angles, isodiametric to heterodiametric (on average heterodiametric) in profile view, apex at first somewhat rounded and $\pm$ triangular (in some becoming truncate and in a few with the angles slightly protuberant); $8.5\text{--}12.5 \times 6.5\text{--}9\text{ }\mu\text{m}$ ($x = 10.4 \pm 0.7 \times 7.7 \pm 0.6\text{ }\mu\text{m}$; $E = 1\text{--}1.6$; $Q = 1.4 \pm 0.1$; $n/3 = 132$). BASIDIA 4-sterigmate; clavate,



PLATE 7 *Leptonia newlingii* (DLL10004 holotype): A. basidiomata (field); B. basidiomata (lab).
Bars = 30 mm.

tapered towards the base, $33\text{--}59 \times 10\text{--}14.5 \mu\text{m}$ ($x = 46.0 \pm 6.6 \times 11.9 \pm 1.1 \mu\text{m}$, $E = 3\text{--}4.6$, $Q = 3.8 \pm 0.5$, $n/2 = 17$). LAMELLAR EDGE fertile. CHEILOCYSTIDIA absent. PLEUROCYSTIDIA absent. LAMELLAR TRAMAL HYPHAE subparallel, moderately long and broad: $53\text{--}180 \times 5\text{--}15 \mu\text{m}$ ($x = 94.5 \pm 31.3 \times 8.7 \pm 2.9 \mu\text{m}$;

E = 5–20; Q = 11.5 ± 4.0 ; n/2 = 16). PILEIPELLIS 90–250 μm (n/1 = 3) deep, composed of trichodermial tufts comprising 3–4 celled hyphae, loosely entangled, and erect terminal cells. PILEOCYSTIDIA cylindro-clavate to clavate, $45\text{--}157 \times 6.5\text{--}12.5 \mu\text{m}$ ($x = 95.8 \pm 27.9 \times 9.6 \pm 1.7 \mu\text{m}$; E = 5–17; Q = 10.2 ± 3.2 ; n/2 = 21). PILEAL TRAMAL HYPHAE subparallel, entangled, short and cylindric to cylindro-clavate; $80\text{--}240 \times 9\text{--}22 \mu\text{m}$ ($x = 152.6 \pm 64.9 \times 15.5 \pm 4.0 \mu\text{m}$; E = 5–15; Q = 9.9 ± 3.6 ; n/2 = 8). STIPITPELLIS composed of loosely entangled hyphae with clavate terminal cells. CAULOCYSTIDIA similar to pileocystidia but shorter and more slender, $50\text{--}123 \times 5\text{--}8 \mu\text{m}$ ($x = 82.3 \pm 20.7 \times 6.9 \pm 0.9 \mu\text{m}$; E = 7–19; Q = 12.2 ± 3.2 ; n/3 = 21). STIPE TRAMAL HYPHAE subparallel and entangled. OLEIFEROUS HYPHAE absent. BRILLIANT GRANULES scattered in the basidia. LIPOID GLOBULES absent. PIGMENTS in pileipellis and stipitipellis bluish and cytoplasmic, soluble in 3% KOH, brownish pigments and encrusted pigments absent. CLAMP CONNECTIONS abundant in all tissues.

ECOLOGY & DISTRIBUTION—Scattered in sandy soil and leaves, in forest between the beach and mangrove stands or in soil under logs in vine forests, in northeastern Queensland, mid-January to late March.

ADDITIONAL COLLECTIONS EXAMINED —AUSTRALIA. QUEENSLAND, Yorkies Knob Beach Forest, $16^{\circ}48'51''\text{S } 145^{\circ}43'47''\text{E}$, 11m, 9 January 2011, P. Newling PN14b; $16^{\circ}48'49''\text{S } 145^{\circ}43'44''\text{E}$, 14 March 2011, DL Largent 10026, $16^{\circ}46'00''\text{S } 145^{\circ}43'49''\text{E}$, 22 March 2012, DL Largent 10313.

DISTINCTIVE CHARACTERS—Basidiomata at first collybioid but soon naucorioid to nearly trichomatoid; pileus at first blackish blue and entirely tomentose or erect squamulose, then dark blue and tomentose on disc and appressed squamulose elsewhere; lamellae yellowish white; stipe fleshy, similar in color to pileus, with ridges and bands of squamules; basal tomentum moderate to abundant; stipe base with rhizoids penetrating the substrate.

COMMENTS—*Leptonia newlingii* and *E. indoviolaceum* (from Kerala state in India; Manimohan et al. 2006) are closely related phylogenetically (BS = 71, FIG. 1). Morphologically, *E. indoviolaceum* is distinguished from *L. newlingii* by its small to medium basidiomata, sterile lamellar edges, longer (11–14 μm) basidiospores, and encrusting pigments in the stipitipellis.

Entoloma panniculus from Tasmania can be distinguished from *L. newlingii* by its smaller basidiomata, farinaceous odor and taste, and encrusting pigments in the stipitipellis.

Since 2009, numerous *L. newlingii* populations have been observed in the fall season, occurring abundantly in sandy soils in coastal vine forests just north of Cairns in northeastern Queensland (P. Newling, pers. obs.).



PLATE 8 *Leptonia newlingii* (DLL10004 holotype): A. pileipellis; B. pileocystidia; C. basidiospores; D. caulocystidia; E. basidium; F. pileocystidia. Bars: A = 170 μ m; B, D, F = 10 μ m; C = 8 μ m; E = 12 μ m.



PLATE 9 *Leptonia ambigua* (DLL10130 holotype): A. basidiomata;
B. basidiospores; C. submoniliform pileipellis. Bars: A = 16 mm; B = 7.5 µm; C = 10 µm.

Leptonia ambigua Largent, Mycotaxon 125: 18 (2013).

PLATE 9

COMMENTS—Our analysis supports the placement of *L. ambigua* within a sub-clade that includes *Entoloma euchroum* (FIG. 1). *Leptonia ambigua* can be distinguished from the other species within this sub-clade by its isodiametric to subisodiametric basidiospores with 6–7(–8) angles and a pileipellis of submoniliform clampless hyphae (PLATE 9C). For a discussion of morphological similarities and differences with other entolomatoid species see the description of *L. ambigua* in Largent et al. (2013b).

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